

Table of Contents

Abstract..... i

Acknowledgements..... ii

Table of Contents..... iii

List of Figures vii

List of Tables viii

Abbreviation ix

Chapter 1 Introduction 1

 1.1 Introduction to Networking Technologies 2

 1.1.1 Introduction of OSI Reference Model 3

 1.1.1.1 The Application Layer 3

 1.1.1.2 The Presentation Layer 4

 1.1.1.3 The Session Layer..... 4

 1.1.1.4 The Transport Layer 5

 1.1.1.5 The Network Layer 5

 1.1.1.6 The Data Link Layer..... 6

 1.1.1.7 The Physical Layer 6

 1.1.2 Mapping TCP/IP model with OSI Model 7

 1.1.2.1 Physical and Data Link Layers 7

 1.1.2.2 Network Layer 8

 1.1.2.3 Transport Layer..... 8

 1.1.2.4 Application Layer 8

 1.1.3 Introduction to Transmission Control Protocol 10

 1.2 Introduction to Simulation 11

 1.3 Objective of The Thesis 12

 1.4 Scope of The Thesis..... 12

 1.5 Report Organizations 12

Chapter 2 LITERATURE REVIEW..... 14

 2.1 An introduction to TCP..... 14

 2.1.1 TCP congestion control..... 14

 2.1.1.1 Slow Start and Congestion Avoidance 15

2.1.1.2	Fast Retransmit and Fast Recovery.....	17
2.1.2	TCP Terminology	18
2.1.2.1	Lost Segment	18
2.1.2.2	Duplicate Acknowledgement.....	18
2.1.2.3	Slow Start Threshold.....	19
2.1.2.4	Retransmission Time-out (RTO)	19
2.1.3	TCP version of Congestion Control Algorithms	20
2.1.3.1	Introduction to Tahoe.....	21
2.1.3.2	Introduction to Reno	21
2.1.3.3	Introduction to New Reno.....	22
2.1.3.4	Introduction of Selective Acknowledgement.....	23
2.1.3.5	Summary of TCP version.....	23
Chapter 3	Computer Network Simulation	24
3.1	Computer Simulation	24
3.1.1	Simulation Model.....	25
3.1.2	Simulation Approach	26
3.2	Current Existing Network Simulators.....	27
3.2.1	INSANE.....	27
3.2.2	OMNET++.....	28
3.2.3	OPNET.....	29
3.2.4	PARSEC	30
3.2.5	REAL Network Simulator	30
3.2.6	NIST ATM/HFC.....	31
3.2.7	NS-2	32
3.2.8	DELSI	33
Advantages.....		34
Disadvantages		34
3.2.9	UMJaNetSim.....	34
3.2.10	Summary of Existing Simulator.....	35
3.3	Programming Technique.....	37
3.3.1	Approach.....	37
3.3.1.1	Procedural Approach	37
3.3.1.2	Structure Programming Approach	38
3.3.1.3	Object-Oriented Programming.....	38

3.3.2 Java	39
3.3.3 Tool	40
3.3.3.1 Visual Age	41
3.3.3.2 Visual J++	41
3.3.3.3 Borland's JBuilder	42
3.4 Chapter Summary	42
Chapter 4 UMJaNetSim	44
4.1 UMJaNetSim Architecture	44
4.1.1 Event Management Architecture	45
4.1.1.1 The Simulation Time	47
4.1.2 GUI Management	47
4.1.3 Simulation Components, Parameters and Events	51
4.2 UMJaNetSim API	52
4.2.1 Simulation Events (SimEvent)	53
4.2.2 Simulation Components (SimComponent)	54
4.2.2.1 Instant Information Passing	55
4.2.2.2 "Copy and Paste" Support	56
4.2.2.3 The Event Handler	56
4.2.3 Component Parameters (SimParameter)	57
4.3 UMJaNetSim Features	59
4.4 Chapter Summary	60
Chapter 5 System Design, Implementation and Testing	61
5.1 Object Oriented Design	62
5.2 Class Design	63
5.2.1 TCPIPApp class	63
5.3 TCPIP Simulator Component Implementation	64
5.3.1 TCPIPApp class	64
5.3.1.1 Process Segment Method	65
5.3.1.2 Retransmission and Timeout Methods	66
5.3.2 ATMLSR class	66
5.3.2.1 Attributes	66
5.3.2.2 Dropping packet Methods	67
5.4 TCPIP component Testing	68
5.4.1 Testing	68

5.4.1.1 Tahoe component test69

5.4.1.2 Reno component test.....72

5.4.1.3 New Reno component test74

5.4.2 Performance Evaluation of Overall same TCP version Network Topology
.....77

Case Study: TCPIP component network Topology79

Chapter 6 Conclusion.....80

6.1 Objective Achieved.....80

6.2 Development Outcome81

6.2.1 System Strength81

6.2.2 System Limitation.....82

6.3 Future Enhancement82

6.4 Chapter Summary83

Reference:84

Appendix A88

Case Study: TCP with IP network Topology.....88

Appendix B91

TCP with IP component Configuration Guideline.....91

List of Figures

Figure 1.1 OSI Model	3
Figure 1.2 The OSI and TCP/IP layered structures	7
Figure 2.1 TCP congestion window.....	15
Figure 4.1UMJaNetSim overall architecture	45
Figure 4.2UMJaNetSim event management architecture	46
Figure 4.3UMJaNetSim GUI management structure.....	48
Figure 4.4UMJaNetSim Screenshot (SimPanel).....	48
Figure 4.5UMJaNetSim Screenshot (Parameter Dialogs)	49
Figure 4.6UMJaNetSim Screenshot (Meter Dialogs)	50
Figure 4.7UMJaNetSim Screenshot (Custom Dialog).....	51
Figure 5.1 TCPIP Simulator Objects	62
Figure 5.2 TCPIP component topology	68
Figure 5.3 Tahoe sender sequence number.....	69
Figure 5.4 Tahoe sender congestion window	70
Figure 5.5 Reno sender sequence number	72
Figure 5.6 Reno sender congestion window	73
Figure 5.7 NewReno sender sequence number.....	75
Figure 5.8 NewReno sender congestion window	76
Figure 5.9 TCP/ IP Network Topology Structure.....	77
Figure A.1 TCP/IP Network Topology structure.....	88
Figure B.1 Configure TCP with IP component (1).....	91
Figure B.2 Configure TCP with IP component (2).....	92

List of Tables

Table 3.1 Comparison of Simulators36

Table 5.1 Attributes and Methods of TCPIPApp.....64

Table 5.2 Address Space for TCP with IP component (IPTCP).....78

Table 5.3 Overall network IPTCP Average Throughput 178

Table 5.3 Overall network IPTCP Average Throughput 278

Table 5.4 Overall network IPTCP Average Throughput79

Table A.1 Address Space for TCP with IP component (IPTCP).....89

Table A.2 Destination Address Space for TCP with IP component (IPTCP)89

Table A.3 Over all network IPTCP on Tahoe Average Throughput 190

Table A.4 Over all network IPTCP on Reno Average Throughput 2.....90

Table A.5 Over all network IPTCP on NewReno Average Throughput90

Abbreviation

ACK	Acknowledgement packet
cwnd	Sender Congestion Window
dupACK	Duplicate Acknowledgement
IP	Internet Protocol
LAN	Local Area Network
MSS	Maximum Segment Size
ndup	Duplicate Acknowledgement count
RTT	Round Trip Time
rwnd	Receiver Advertisement Window
SMSS	Sender Maximum Segment Size
ssthresh	Slow Start Threshold
TCP	Transmission Control Protocol
TCP/IP	TCP with IP